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United States Department of Agriculture
Agricultural Research Administration
7 (U.S. Bureau of Plant Industry, Soils,
and Agricultural Engineering.

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H. T. & S. Office Report No. 285)

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The Effect of Prestorage Treatments and Storage Temperatures on the Keeping Quality of Florida Grapefruit at Orlando, Florida, and New York City, N. Y.
1952

FEB 13 1953
U.S.

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Division of Handling, Transportation and Storage
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Report of a study made under the
Research and Marketing Act of 1946
Project No. RM:C-413

6c
December 1952
Orlando, Florida
New York City, N. Y.

THE EFFECT OF PRESTORAGE TREATMENTS AND STORAGE TEMPERATURES ON THE KEEPING QUALITY OF FLORIDA GRAPEFRUIT AT ORLANDO, FLORIDA, AND NEW YORK CITY, N. Y.
1952[1]

This is a report of the 1952 storage experiments with Duncan and Marsh seedless grapefruit conducted at Orlando, Florida, and New York, N. Y. The tests were a part of the investigation on the storage of citrus fruits conducted by the Bureau of Plant Industry, Soils and Agricultural Engineering, and The Refrigeration Research Foundation.

SUMMARY AND DISCUSSION

This report includes the results of several tests that were conducted to determine the effect of Dowicide A-hexamine, phenodor liners, curing, and different temperatures on the keeping quality of Florida grapefruit during storage. It may be observed that the Dowicide A-hexamine treatment was given major consideration throughout the study. The results show that it gave some control of decay in most of the storage tests but not enough to warrant the commercial storage of grapefruit for more than a few weeks.

The general findings showed that usually small percentages of decay developed during the storage period of 4 to 8 weeks at 32° and 38°F. Higher percentages occurred in the fruit stored at 45°, 50° and 55°, and in most instances the decay was in advanced stages of development. Very high percentages of decay occurred during the holding period following storage, especially in those lots that were held 7 days at 70°.

Keeping quality was influenced by the length of the storage period as would be expected, and smaller amounts of decay and rind breakdown developed in 4 weeks' storage than in 6 or 8 weeks'.

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[1] Acknowledgment is due W. T. Pentzer, U. S. Department of Agriculture, Beltsville, Md.; H. C. Diehl, Director of The Refrigeration Research Foundation, Colorado Springs, Colo.; A. W. Cooner, of the Florida Citrus Commission, Lake Alfred, Fla.; and to the following staff members of the Division of Handling, Transportation, and Storage of Horticultural Crops: John W. Huddleston, J. M. Lutz, W. A. Radspinner, G. Lee Roberts, and Mrs. Vera Staples. Acknowledgment is also due the following growers, shippers and cold storage warehouse officials for their generous cooperation: American Fruit Growers, Inc.; Mrs. K. D. Brunstrum; Chase and Co.; Randall Chase; Frank Chase; Sydney Chase; Corbett Hutchinson; W. Kinney; J. I. Lyle III; Merchants Refrigerating Co., New York City; Orlando Citrus Growers Assn.; Arthur N. Otis; A. E. Pickard; D. P. Schnuck; V. H. Sley; Orwin Ward; and J. G. Welsh.

Prestorage applications of Dowicide A-hexamine generally resulted in a marked reduction in decay as compared with untreated fruit. The exception occurred in storage tests at New York in which the Dowicide treatment failed to give consistent control of decay.

Dowicide A-hexamine reduced the development of both stem-end rot and penicillium rot in stored grapefruit. Stem-end rots were more frequent than penicillium rots in the first and second inspections made at time of removal from storage and after 3 days at 70°F., respectively. In the third inspection, penicillium rots were the most prevalent.

After 7 days at 70°F. phenodor-treated box liners did not consistently reduce decay during storage. In fact, the results frequently showed higher percentages of decayed fruits in the phenodor than in the naked packs.

Curing had no beneficial effect on grapefruit stored at 32° and 38°F., whereas, at 50° a slight reduction in decay may be attributed to it.

Moderate amounts of pitting developed on the grapefruit in storage. Pitting was generally more prevalent at 32° and 38° than at 50° or 55°F., although in the New York tests pitting was effectively controlled at 32° for 4 weeks. Pitting was influenced by the length of the storage period and greater amounts occurred during 8 weeks than 4 weeks. The results showed that pitting was slightly increased by the Dowicide A-hexamine treatment and by phenodor liners.

Aging was usually commercially unimportant. Slightly more aging was found in the fruit stored for 8 weeks than 4 weeks.

The loss in weight of grapefruit was not an important factor. It depended on the length of the storage period, and ranged between 1.7 to 3.2 percent. The fruit lost more weight at 50° than at 32°F. storage, and in naked packs than in boxes with phenodor liners.

During storage there was a marked tendency for total acid and ascorbic acid (vitamin C) to decrease. The trend in total solids was irregular. Dowicide A-hexamine treatments and phenodor liners had no significant effect on composition.

MATERIALS AND METHODS

The 1952 storage studies with Florida grapefruit were conducted at Orlando, Fla., and New York City, N. Y. Fruits of the Duncan and Marsh varieties, grown on rough lemon rootstock in groves located in Orange County were used.

The commercial packinghouse treatment consisted of washing, waxing, polishing, grading, sizing, and packaging the fruit in Bruce boxes. These lots represented the "controls." Comparison was made between commercial packs and Dowicide A-hexamine treatment. In some tests naked and phenodor-lined packs were also compared with both treated and untreated fruit. Briefly the Dowicide A-hexamine treatment consisted of exposure of the fruit for 2 minutes in a solution of 2 percent Dowicide A- (sodium orthophenylphenate), 1 percent hexamine (hexa methylene-tetramine), and 0.05 percent palmolive soap in the dip tank. In the storage tests at Orlando, the Dowicide treatment was applied by submerging the field boxes of fruit in a small tank containing the Dowicide solution. This was done manually. The method of treatment differed from the test samples that were shipped to New York City for storage which will be discussed later.

At Orlando, the storage temperatures were 32°, 38°, and 50°F., and relative humidity 79 to 87 percent.

The investigation at New York was with Duncan grapefruit. Commercially-packed fruit was compared with comparable samples treated with the Dowicide solution. Storage was for 4 and 8 weeks at 32°, 38°, 45°, 50°, and 55°F., and a relative humidity of 75 to 83 percent. The Dowicide A-hexamine solution was applied in a commercial manner, with the Dowicide solution substituted for color-added in the color-added tank. The packed test boxes of fruit were precooled 24 hours, shipped in a fan car with commercial shipments under Standard Refrigeration from Windermere, Fla., May 16, unloaded May 20 at Newark, N. J., and trucked to New York City where it was placed in storage, May 21. Fruit temperatures in the test boxes at top bunker position dropped slowly during transit, from 72° to 48°, while those at the bottom bunker position dropped slowly from 71° to 37°.

The studies were designed to determine the effect of storage on quality of:

1. Duncan grapefruit picked March 5, treated with Dowicide A-hexamine, packed with and without phenodor liners and stored at Orlando, March 6, for 4 and 6 weeks at 32° and 50°F.

2. Duncan grapefruit picked May 7, treated with Dowicide A-hexamine, packed with and without phenodor liners and stored at Orlando, May 9, for 4 and 8 weeks at 32°, 38°, and 50°F.

3. Duncan grapefruit picked May 7, cured 60 hours at 84°F., treated with Dowicide A-hexamine, packed naked and stored at Orlando, May 10, for 4 and 8 weeks at 32°, 38°, and 50°F.

4. Marsh grapefruit picked June 2, treated with Dowicide A-hexamine, packed naked and stored at Orlando, June 4, for 4 and 8 weeks at 32°, 38°, and 50°F.

5. Duncan grapefruit picked May 14, treated with Dowicide A-hexamine, packed naked, precooled 24 hours, shipped in fan car to Newark, N. J., and stored at New York City, May 21, for 4 and 8 weeks at 32°, 38°, 45°, 50°, and 55°F.

Each of the subsamples (including the "controls") consisted of at least 5 box-lots. Withdrawals from storage were after 4, 6, and 8 weeks. The market life was determined by holding 7 days at 70°F.

The methods of procedure and inspection of fruit were similar to the former tests (see H.T.&S. Office Reports numbers 266 and 269). Fruit showing both aging and pitting was scored under the defect considered the more serious blemish. Decay was always considered more serious than any type of skin breakdown. Decayed fruits were scored under stem-end rot when the symptoms were characteristic of diplodia rot or phomopsis rot, whether or not the decay occurred at the stem end. Three inspections were made, namely, at the time the boxes of fruit were removed from storage, and after 3 days and 7 days at 70°F. and 70 to 90 percent relative humidity.

The phenodor (diphenyl-treated) liners were removed at the first inspection. Decayed grapefruits at the first and second inspections were discarded before repacking the sound fruit into the test boxes. The amount of decay for the second and third inspection is cumulative, that is, it includes decay counts for all previous inspections. Pitting and aging records at the second and third inspections are not cumulative, but instead, are based on actual counts made at the particular inspection. It should be noted that decays other than stem-end rot and penicillium rot are not listed by specific types, but are included with total of decay in each instance. Thus, total of decay may be greater than the sum of stem-end rot and penicillium rot.

RESULTS

Preliminary storage tests with Duncan grapefruit stored March 6, at Orlando, Florida

Storage results in 1951 (see H.T.&S. Office Report 266) showed that Valencia oranges treated with Dowicide A-hexamine solution in the dip tank developed much less decay in storage than did similar untreated fruit. Phenodor liners afforded additional protection against decay. In view of these results on Valencia oranges, it was deemed advisable to ascertain the fungicidal value of this chemical treatment, and of phenodor liners on stored grapefruit. A preliminary test was conducted in March with Duncan grapefruit several weeks in advance of the commercial storage season. Storage was at 32° and 50°F. for 4 and 6 weeks.

The general results (table 1) show very small percentages of decay at the end of 4 or 6 weeks at 32°F., with only a slight increase in total decay during the 3-day holding period at 70°. However, at 70°, decay did develop rapidly between the third and seventh day. Total decay was greater at the end of 4 and 6 weeks' storage at 50° than at 32°. It was also greater after 3 days at 70°, but at the end of the 7-day holding period at 70°, total decay was greater in the grapefruit stored at 32° than that stored at 50°.

There was less decay in the grapefruit that received the prestorage packinghouse treatment of Dowicide A-hexamine but the total decay was fairly high after 7 days at 70°F., especially in fruit stored for 6 weeks.

In most cases there was less decay in grapefruit packed in phenodor-lined boxes than in those without the liners, but the differences were much smaller than between the Dowicide A-hexamine treated and untreated fruit (table 2).

There was less moderate and severe pitting in the Dowicide A-hexamine treated grapefruit than on the untreated (table 3). On the other hand phenodor liners increased pitting at 32°F. (table 4).

Aging in grapefruit was not of commercial importance and is not shown in tabular form. The data indicated that less aging occurred in grapefruit stored at 32° than at 50°F., and smaller percentages were evident after 4 weeks' than after 6 weeks' storage.

Fruit stored May 9, at Orlando, Florida

During the commercial storage season, additional storage tests were conducted in order to reappraise the Dowicide A-hexamine treatment, and phenodor liners in the control of decay. The study was with Duncan grapefruit stored for 4 and 8 weeks at 32°, 38°, and 50°F. Three inspections were made following removal of the fruit from storage.

The general findings showed that very small amounts of decay developed in the treated grapefruit when removed from storage after 4 and 8 weeks at 32° and 38°F. A higher percentage of decay was found in both treated and untreated fruit that had been stored at 50°. All of the lots showed much decay after 7 days at 70°, and the fruit stored 8 weeks developed more than that held in storage 4 weeks (table 5).

It was found (table 5) that total decay was consistently less in the fruit treated with Dowicide A-hexamine. The treatment was particularly effective when the storage temperature was 32° and 38°F., and when the holding period after storage was for only 3 days.

In these tests phenodor liners did not consistently control decay as compared with unlined boxes (table 6). In some boxes with liners there was more decay. The practical value of these phenodor liners for the storage of grapefruit is questioned.

Pitting was consistently worse in the Dowicide A-hexamine treated fruit stored at 32°F. than it was in the untreated fruit (table 7). Differences were small and inconsistent at 38° and 50°. Grapefruit had a fresher appearance and showed less shriveling in the phenodor-liner pack than in the "naked" pack. The amount of pitting differed little between lined and unlined boxes (table 8).

The effect of curing on decay, pitting, and aging of grapefruit stored May 9 and 10, at Orlando, Florida

A study was made to determine the effect of curing on keeping quality of stored grapefruit of the Duncan variety. Prestorage curing consisted of 60 hours at 84°F., followed by storage for 4 and 8 weeks at 32°, 38°, and 50°.

In table 9 it will be seen that at 32° and 38° storage, higher percentages of decay usually occurred in the cured than in the uncured fruit. Curing resulted in a slight reduction of decay in the fruit stored at 50°F. However, total decay was high and curing did not appear to offer a solution to the problem of storing grapefruit.

Storage temperatures had an effect on pitting and more was found at 32° and 38° than at 50°F. The cured fruit had somewhat less pitting than uncured fruit at the 4 weeks' removal, but the reverse was generally the case after 8 weeks' storage (table 10).

In this investigation, aging was of minor importance (table 11). Less aging was found at 50° storage than at either 32° or 38°F. Less aging occurred in most lots of cured fruit stored at 32° and 38°, but the results were not always consistent. At 50°, there was very little aging but more in the cured than in the uncured fruit.

The relation of prestorage treatments to keeping quality of late-picked Marsh grapefruit stored June 4, at Orlando, Florida

Storage tests were made to ascertain the value of Dowicide A-hexamine as a prestorage treatment on late-picked grapefruit. The tests were with Marsh (seedless) grapefruit and stored 4 and 8 weeks at temperatures of 32°, 38°, and 50°. The usual inspections were made after removal from storage, and after holding at 70°F.

The general findings were similar to those reported earlier in this report, i.e., comparatively small percentages of decay were present when fruit was removed from 4 weeks' storage at 32° and 38°F. (Table 12) Decay was greater at 50°. High percentages of decay usually developed during the 7-day holding period at 70° especially when the storage was extended to 8 weeks. Dowicide A-hexamine reduced total decay in all but one lot. The results show that decay was controlled fairly satisfactorily by the Dowicide treatment when the storage periods were 4 and 8 weeks at 32° and 38°, and when the fruit was held only 3 days at 70° after removal from storage. It might be of interest to note that less total decay developed in lots of fruit held in storage at 38° than at 32°. Attention should be called to the decayed fruit in 50° storage. In these lots the decays were usually in an advanced stage with mold spores coating adjacent fruits. Frequently the test boxes were leaking from rotted grapefruit. This condition was not encountered in 32° or 38° storages, although the percentages of decay were sometimes greater than those stored at 50°.

In these tests it was found (table 13) that pitting did not develop to any great extent. Less pitting was found in the lots of fruit stored at 50° than at 32° or 38°F. The findings indicated that the Dowicide A-hexamine treatment slightly increased pitting.

Skin breakdown in the form of aging was of no economic importance. Prestorage treatments, such as Dowicide A-hexamine, or storage temperatures, had no appreciable influence on the aging found (table 14).

Comparison of decay and rind breakdown in Dowicide A-hexamine and commercially-treated grapefruit at different storage temperatures

New York City, May 21

A series of storage tests were made to determine the effects of pre-storage treatments and different storage temperatures on the quality of Duncan grapefruit. Dowicide A-hexamine and commercially-treated fruits were compared at 32°, 38°, 45°, 50°, and 55°F. In these studies the method of application of the Dowicide differed from the other tests. The treatment was applied in a commercial manner, with the Dowicide A-hexamine solution substituted for color-added in the color-added tank. The findings showed that under these conditions the Dowicide treatment proved less effective in controlling decay, than when the field boxes of fruit were dipped manually in the solution. In this series of tests no clear-cut explanation can be offered for the ineffectiveness of Dowicide A-hexamine to control decay. Some investigators suggested that perhaps a chemical reaction occurred by the substitution of the Dowicide solution in the color-added tank, or that the exposure and coverage was of insufficient duration in the commercial application.

The data presented in table 15 show that very small amounts of decay developed during 4 weeks' storage. Higher percentages of decay occurred in 8 weeks, especially in those lots stored at 45°, 50°, and 55°F. Decay developed rapidly during the 7-day holding period at 70°. The general findings showed better keeping quality of grapefruit at 32° and 38°, than at the higher storage temperatures. All of the lots had excessive amounts of decay 7 days after removal from storage. The fruit stored 8 weeks at 32° held up 3 days after removal, showing only 3 to 4 percent decay.

The results (table 16) show that pitting occurred at all storage temperatures; however, smaller amounts of pitting were found at 55°F. than at most of the other storage temperatures. Pitting was of minor importance at 32° except in the fruit stored 8 weeks and then held at 70° for 3 days or longer. The Dowicide A-hexamine treatment apparently increased pitting in 18 out of 30 comparable lots.

Skin breakdown in the form of severe aging was of minor importance. (Table 17) Slightly more severe aging was found on the grapefruit stored at 38°, 45°, and 50° than at 32° or 55°F. The results show that the Dowicide treatment had no consistent effect on aging of stored grapefruit.

The control of stem-end rot and penicillium rot by the Dowicide A-hexamine treatment

The storage data obtained at Orlando and New York City were regrouped for comparative purposes. Table 18 shows the difference in percentage of stem-end rot and penicillium rot in the Dowicide A-hexamine and the commercially treated fruit. It will be noted that there was less stem-end rot and penicillium rot at all inspections in the Dowicide-treated fruit. Stem-end rots were slightly more numerous than penicillium rots in the first and second inspections, whereas, in the third inspection penicillium rots were more common.

Loss in weight of grapefruit during storage

The data showed that loss in weight of grapefruit was influenced by the length of the storage period, temperature, and type of pack. The average loss in weight amounted to 1.7 percent in 4 weeks' and 3.2 percent in 8 weeks' storage. There was a greater average loss in weight at 50°F. than at 32° storage. Loss in weight at 38° was intermediate. The grapefruit appeared fresher and lost less weight in the phenodor-lined packs than in naked packs. The Dowicide A-hexamine treatment had no significant effect on loss in weight during storage.

Changes in the composition of grapefruit

Chemical analyses were made on the juice of Duncan grapefruit to determine the changes in total acid, total solids, and ascorbic acid, during storage. The general trends at 32°, 38°, and 50°F. are presented graphically in figures 1 and 2. Total acid and ascorbic acid (vitamin C) decreased during storage. The total solids content was somewhat irregular. It may be observed that storage temperature had a slight influence on total solids and total acid with slightly higher amounts in the fruit stored at 50°, than in those stored at 32° or 38°. Prestorage treatments, such as Dowicide A-hexamine, naked, and phenodor-lined packs appeared to exert little effect on fruit composition. The cured lots of grapefruit also showed a decrease in total acid and ascorbic acid during storage and total solids increased slightly, then decreased. A temperature of 50° appeared to result in the greatest decrease in acid. Except for the lower acid content in the lot stored at 50°, the composition of the cured fruit was similar to the uncured fruit.

TABLE 1. The effect of Dowicide A-hexamine treatment on decay in early-picked Duncan grapefruit, Orlando, Florida, March 6, 1952.[1]

Storage temperature	Fruit treatment	Decay after 4 weeks storage plus			Decay after 6 weeks storage plus		
		0 days at 70°F.	3 days at 70°F.	7 days at 70°F.	0 days at 70°F.	3 days at 70°F.	7 days at 70°F.
		Percent	Percent	Percent	Percent	Percent	Percent
32°F.	Commercial treatments (naked and liner packs)	.5	.8	27.3	.2	1.4	41.6
	Dowicide A-hexamine treatments (naked and liner packs)	0	0	3.5	0	.2	9.6
50°F.	Commercial treatments (naked and liner packs)	5.0	7.4	17.0	9.2	13.4	25.0
	Dowicide A-hexamine treatments (naked and liner packs)	0	.6	2.1	1.3	1.3	7.0

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[1] Data based on averages of subsamples (6-box lots) for all the commercial Dowicide **A**-hexamine treatments, and for all naked-liner packs.

TABLE 2. The effect of phenodor liners on decay in early-picked Duncan grapefruit, Orlando, Florida, March 6, 1952.[1]

Storage temperature	Fruit treatment	Decay after 4 weeks storage plus			Decay after 6 weeks storage plus		
		0 days at 70°F.	3 days at 70°F.	7 days at 70°F.	0 days at 70°F.	3 days at 70°F.	7 days at 70°F.
		Percent	Percent	Percent	Percent	Percent	Percent
32°F.	Naked packs (commercial and Dowicide A-hexamine treatments)	.3	.3	16.4	0	1.1	29.7
	Liner packs (commercial and Dowicide A-hexamine treatments)	.3	.6	14.3	.2	.5	21.6
50°F.	Naked packs (commercial and Dowicide A-hexamine treatments)	3.7	5.3	10.1	6.3	8.5	17.9
	Liner packs (commercial and Dowicide A-hexamine treatments)	1.3	2.7	9.0	4.2	6.3	14.1

1/ Data based on averages of subsamples (6-box lots) for all of the naked-liner packs, and for all commercial - Dowicide A-hexamine treatments.

TABLE 3. The effect of Dowicide A-hexamine treatment on pitting in early-picked Duncan grapefruit, Orlando, Florida, March 6, 1952.[1]

Storage temperature	Fruit treatment	Moderate and severe pitting after 4 weeks storage plus			Moderate and severe pitting after 6 weeks storage plus		
		0 days at 70°F.	3 days at 70°F.	7 days at 70°F.	0 days at 70°F.	3 days at 70°F.	7 days at 70°F.
		Percent	Percent	Percent	Percent	Percent	Percent
32°F.	Commercial treatments (naked and liner packs)	.8	11.1	12.7	22.2	42.3	25.8
	Dowicide A-hexamine treatments (naked and liner packs)	.3	5.1	12.4	9.8	23.9	27.7
50°F.	Commercial treatments (naked and liner packs)	6.3	10.3	9.8	9.2	11.6	10.5
	Dowicide A-hexamine treatments (naked and liner packs)	.8	3.2	5.3	5.4	8.8	9.4

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[1] Data based on averages of subsamples (6-box lots) for all of the commercial - Dowicide A-hexamine treatments, and for all naked - liner packs.

TABLE 4. The effect of phenodor liners on pitting in early-picked Duncan grapefruit, Orlando, Florida, March 6, 1952.[1]

Storage temperature	Fruit treatment	Moderate and severe pitting after 4 weeks storage plus			Moderate and severe pitting after 6 weeks storage plus		
		0 days at 70°F.	3 days at 70°F.	7 days at 70°F.	0 days at 70°F.	3 days at 70°F.	7 days at 70°F.
		Percent	Percent	Percent	Percent	Percent	Percent
32°F.	Naked packs (commercial and Dowicide A-hexamine treatments)	.3	4.5	9.8	9.0	30.4	23.2
	Liner packs (commercial and Dowicide A-hexamine treatments)	.8	11.7	15.4	23.0	35.9	30.3
50°F.	Naked packs (commercial and Dowicide A-hexamine treatments)	4.8	9.3	9.8	7.0	11.0	11.0
	Liner packs (commercial and Dowicide A-hexamine treatments)	2.4	4.2	5.3	7.6	9.4	9.0

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[1] Data based on averages of subsamples (6-box lots) for all of the naked-liner packs, and for all commercial - Dowicide A-hexamine treatments.

TABLE 5. The effect of Dowicide A-hexamine treatment on decay in Duncan grapefruit, Orlando, Florida, May 9, 1952.[1]

Storage temperature	Fruit treatment	Decay after 4 weeks storage plus			Decay after 8 weeks storage plus		
		0 days at 70°F.	3 days at 70°F.	7 days at 70°F.	0 days at 70°F.	3 days at 70°F.	7 days at 70°F.
		Percent	Percent	Percent	Percent	Percent	Percent
32°F.	Commercial treatments (naked and liner packs)	.5	1.5	27.4	.9	3.3	62.2
	Dowicide A-hexamine treatments (naked and liner packs)	0	0	11.8	.5	1.3	48.2
38°F.	Commercial treatments (naked and liner packs)	2.1	8.0	23.6	8.8	12.4	58.5
	Dowicide A-hexamine treatments (naked and liner packs)	0	1.1	13.9	1.3	3.3	46.2
50°F.	Commercial treatments (naked and liner packs)	15.6	22.8	35.8	50.3	55.3	71.0
	Dowicide A-hexamine treatments (naked and liner packs)	6.6	12.3	25.2	27.5	31.9	57.0

[1] Data based on averages of subsamples (10-box lots) for all of the commercial - Dowicide A-hexamine treatments, and for all naked and liner packs.

TABLE 6. The effect of phenodor liners on decay in Duncan grapefruit, Orlando, Florida, May 9, 1952.[1]

Storage temperature	Fruit treatment	Decay after 4 weeks storage plus			Decay after 8 weeks storage plus		
		0 days at 70°F.	3 days at 70°F.	7 days at 70°F.	0 days at 70°F.	3 days at 70°F.	7 days at 70°F.
		Percent	Percent	Percent	Percent	Percent	Percent
32°F.	Naked packs (commercial and Dowicide A-hexamine treatments)	.4	.9	25.4	.5	2.4	65.8
	Liner packs (commercial and Dowicide A-hexamine treatments)	.2	.6	13.8	.9	2.2	44.6
38°F.	Naked packs (commercial and Dowicide A-hexamine treatments)	.5	4.0	21.5	5.2	8.9	55.5
	Liner packs (commercial and Dowicide A-hexamine treatments)	1.6	5.1	16.0	5.0	6.8	49.2
50°F.	Naked packs (commercial and Dowicide A-hexamine treatments)	12.0	19.2	35.3	34.6	39.2	62.7
	Liner packs (commercial and Dowicide A-hexamine treatments)	10.2	16.0	25.7	43.1	48.0	65.3

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[1] Data based on averages of subsamples (10-box lots) for all of the commercial and Dowicide A-hexamine treatments and for all of the naked-liner packs.

TABLE 7. The effect of Dowicide A-hexamine treatment on pitting in Duncan grapefruit, Orlando, Florida, May 9, 1952.[1]

Storage temperature	Fruit treatment	Moderate and severe pitting after 4 weeks storage plus			Moderate and severe pitting after 8 weeks storage plus		
		0 days at 70°F.	3 days at 70°F.	7 days at 70°F.	0 days at 70°F.	3 days at 70°F.	7 days at 70°F.
		Percent	Percent	Percent	Percent	Percent	Percent
32°F.	Commercial treatments (naked and liner packs)	2.7	5.1	7.4	6.3	9.5	1.6
	Dowicide A-hexamine treatments (naked and liner packs)	6.8	8.9	12.5	10.0	12.8	7.6
38°F.	Commercial treatments (naked and liner packs)	4.5	4.5	6.3	7.1	9.2	3.9
	Dowicide A-hexamine treatments (naked and liner packs)	2.7	6.0	7.5	9.1	11.9	7.4
50°F.	Commercial treatments (naked and liner packs)	1.3	2.1	1.5	.3	.2	0
	Dowicide A-hexamine treatments (naked and liner packs)	3.4	4.1	2.3	.7	.5	1.8

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[1] Data based on averages of subsamples (10-box lots) for all of the commercial - Dowicide A-hexamine treatments, and for all naked and liner packs.

TABLE 8. The effect of phenodor liners on pitting in Duncan grapefruit, Orlando, Florida, May 9, 19[illegible].[1]

Storage temperature	Fruit treatment	Moderate and severe pitting after 4 weeks storage plus			Moderate and severe pitting after 8 weeks storage plus		
		0 days at 70°F.	3 days at 70°F.	7 days at 70°F.	0 days at 70°F.	3 days at 70°F.	7 days at 70°F.
		Percent	Percent	Percent	Percent	Percent	Percent
32°F.	Naked packs (commercial and Dowicide A-hexamine treatments)	4.2	7.5	8.2	7.2	10.9	3.3
	Liner packs (commercial and Dowicide A-hexamine treatments)	5.3	6.5	11.7	9.0	11.4	5.9
38°F.	Naked packs (commercial and Dowicide A-hexamine treatments)	3.6	6.0	6.1	5.4	7.8	3.4
	Liner packs (commercial and Dowicide A-hexamine treatments)	3.6	4.5	7.7	10.8	13.4	7.9
50°F.	Naked packs (commercial and Dowicide A-hexamine treatments)	2.6	3.1	1.7	.2	.2	1.3
	Liner packs (commercial and Dowicide A-hexamine treatments)	2.1	3.0	2.1	.8	.5	.5

1/ Data based on averages of subsamples (10-box lots) for all of the commercial and Dowicide A-hexamine treatments and for all of the naked and liner packs.

TABLE 9. The effect of curing on decay in Duncan grapefruit, Orlando, Florida, May 9-10, 1952.[1/]

Storage temperature	Fruit treatment	Decay after 4 weeks storage plus			Decay after 8 weeks storage plus		
		0 days at 70°F.	3 days at 70°F.	7 days at 70°F.	0 days at 70°F.	3 days at 70°F.	7 days at 70°F.
		Percent	Percent	Percent	Percent	Percent	Percent
32°F.	Immediate storage (commercial and Dowicide A-hexamine treatments)	.4	.9	25.4	.5	2.4	65.8
	Cured (60 hours at 84°F.) (commercial and Dowicide A-hexamine treatments)	.7	2.6	36.2	2.6	4.4	48.3
38°F.	Immediate storage (commercial and Dowicide A-hexamine treatments)	.5	4.0	21.5	5.2	8.9	55.5
	Cured (60 hours at 84°F.) (commercial and Dowicide A-hexamine treatments)	1.2	4.2	20.8	6.7	12.2	45.1
50°F.	Immediate storage (commercial and Dowicide A-hexamine treatments)	12.0	19.2	35.3	34.6	39.2	62.7
	Cured (60 hours at 84°F.) (commercial and Dowicide A-hexamine treatments)	11.4	16.8	27.2	32.4	38.4	59.6

[1/] Data based on averages of subsamples (10 box-lots) for all of the commercial and Dowicide A-hexamine treatments.

TABLE 10. The effect of curing on pitting in Duncan grapefruit, Orlando, Florida, May 9-10, 1952.[1]

Storage temperature	Fruit treatment	Moderate and severe pitting after 4 weeks storage plus			Moderate and severe pitting after 8 weeks storage plus		
		0 days at 70°F.	3 days at 70°F.	7 days at 70°F.	0 days at 70°F.	3 days at 70°F.	7 days at 70°F.
		Percent	Percent	Percent	Percent	Percent	Percent
32°F.	Immediate storage (commercial and Dowicide A-hexamine treatment)	4.2	7.5	8.2	7.2	10.9	3.3
	Cured (60 hours at 84°F.) (commercial and Dowicide A-hexamine treatment)	2.9	5.6	4.6	5.6	12.6	4.9
38°F.	Immediate storage (commercial and Dowicide A-hexamine treatment)	3.6	6.0	6.1	5.4	7.8	3.4
	Cured (60 hours at 84°F.) (commercial and Dowicide A-hexamine treatment)	2.7	5.9	8.7	12.3	16.7	10.0
50°F.	Immediate storage (commercial and Dowicide A-hexamine treatment)	2.6	3.1	1.7	.2	.2	1.3
	Cured (60 hours at 84°F.) (commercial and Dowicide A-hexamine treatment)	.2	2.2	.4	.9	1.0	.5

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[1] Data based on averages of subsamples (10 box-lots) for all of the commercial and Dowicide A-hexamine treatments.

TABLE 11. The effect of curing on aging in Duncan grapefruit, Orlando, Florida, May 9-10, 1952.[1/]

Storage temperature	Fruit Treatment	Severe aging after 4 weeks storage plus			Severe aging after 8 weeks storage plus		
		0 days at 70°F.	3 days at 70°F.	7 days at 70°F.	0 days at 70°F.	3 days at 70°F.	7 days at 70°F.
		Percent	Percent	Percent	Percent	Percent	Percent
32°F.	Immediate storage (commercial and Dowicide A-hexamine treatments)	0	.8	1.2	1.6	2.8	1.5
	Cured (60 hours at 84°F.) (commercial and Dowicide A-hexamine treatments)	0	.5	.7	1.3	3.2	1.2
38°F.	Immediate storage (commercial and Dowicide A-hexamine treatments)	.7	.9	1.1	.3	1.2	1.0
	Cured (60 hours at 84°F.) (commercial and Dowicide A-hexamine treatments)	0	.2	.2	.2	1.3	1.2
50°F.	Immediate storage (commercial and Dowicide A-hexamine treatments)	0	0	0	0	.2	0
	Cured (60 hours at 84°F.) (commercial and Dowicide A-hexamine treatments)	.2	0	.5	0	.6	.9

[1/] Data based on averages of subsamples (10-box lots) for all of the commercial and Dowicide A-hexamine treatments.

TABLE 12. The effect of Dowicide A-hexamine on decay in late-picked Marsh grapefruit, Orlando, Florida, June 4, 1952.[1]

Storage temperature	Fruit treatment	Decay after 4 weeks storage plus			Decay after 8 weeks storage plus		
		0 days at 70°F.	3 days at 70°F.	7 days at 70°F.	0 days at 70°F.	3 days at 70°F.	7 days at 70°F.
		Percent	Percent	Percent	Percent	Percent	Percent
32°F.	Commercial treatments (naked packs)	0	2.8	35.1	.5	10.1	74.3
	Dowicide A-hexamine treatments (naked packs)	.7	.7	13.4	0	4.3	44.7
38°F.	Commercial treatments (naked packs)	.7	1.9	16.2	4.7	13.2	63.0
	Dowicide A-hexamine treatments (naked packs)	.2	.5	7.4	0	1.2	27.4
50°F.	Commercial treatments (naked packs)	8.5	12.7	25.2	38.6	46.2	57.3
	Dowicide A-hexamine treatments (naked packs)	.4	2.9	11.4	16.5	22.4	39.2

[1] Data based on averages of subsamples (5-box lots).

TABLE 13. The effect of Dowicide A-hexamine treatments on pitting in late-picked Marsh grapefruit, Orlando, Florida, June 4, 1952.[1]

Storage temperature	Fruit treatment	Moderate and severe pitting after 4 weeks storage plus			Moderate and severe pitting after 8 weeks storage plus		
		0 days at 70°F.	3 days at 70°F.	7 days at 70°F.	0 days at 70°F.	3 days at 70°F.	7 days at 70°F.
		Percent	Percent	Percent	Percent	Percent	Percent
32°F.	Commercial treatments (naked packs)	.9	1.7	1.7	2.4	5.2	1.4
	Dowicide A-hexamine treatments (naked packs)	3.3	6.2	4.0	7.1	9.7	8.2
38°F.	Commercial treatments (naked packs)	1.9	1.9	1.1	4.2	9.2	1.6
	Dowicide A-hexamine treatments (naked packs)	2.3	3.5	3.1	2.6	4.7	5.9
50°F.	Commercial treatments (naked packs)	1.5	2.0	.7	.2	0	.2
	Dowicide A-hexamine treatments (naked packs)	1.6	2.9	2.2	1.4	1.2	1.2

[1] Data based on averages of subsamples (5-box lots).

TABLE 14. The effect of Dowicide A-hexamine treatments on aging in late-picked Marsh grapefruit, Orlando, Florida, June 4, 1952.[1]

Storage temperature	Fruit treatment	Severe aging after 4 weeks storage plus			Severe aging after 8 weeks storage plus		
		0 days at 70°F.	3 days at 70°F.	7 days at 70°F.	0 days at 70°F.	3 days at 70°F.	7 days at 70°F.
		Percent	Percent	Percent	Percent	Percent	Percent
32°F.	Commercial treatments (naked packs)	0	0	.2	1.2	1.2	.5
	Dowicide A-hexamine treatments (naked packs)	0	.2	.5	.5	2.1	1.2
38°F.	Commercial treatments (naked packs)	0	.5	.2	3.1	5.4	1.9
	Dowicide A-hexamine treatments (naked packs)	0	.7	.7	.5	4.5	4.5
50°F	Commercial treatments (naked packs)	.9	0	1.1	.2	.5	.7
	Dowicide A-hexamine treatments (naked packs)	.4	.2	.7	.2	.2	0

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[1] Data based on averages of subsamples (5-box lots).

TABLE 15. The effect of different storage temperatures and Dowicide A-hexamine on decay in Duncan grapefruit stored at New York City, May 21, 1952.[1]

Storage temperature	Fruit treatment	Decay after 4 weeks storage plus			Decay after 8 weeks storage plus		
		0 days at 70°F.	3 days at 70°F.	7 days at 70°F.	0 days at 70°F.	3 days at 70°F.	7 days at 70°F.
		Percent	Percent	Percent	Percent	Percent	Percent
32°F.	Commercial treatments	0	.3	23.3	.7	4.6	33.5
	Dowicide A-hexamine treatments	.3	.7	28.2	.3	3.2	29.4
38°F.	Commercial treatments	0	0	22.6	3.3	7.5	49.5
	Dowicide A-hexamine treatments	.7	1.0	20.3	1.3	5.8	49.0
45°F.	Commercial treatments	.6	2.0	24.0	5.9	16.1	53.3
	Dowicide A-hexamine treatments	1.0	3.3	22.2	5.8	15.6	48.2
50°F.	Commercial treatments	0	2.2	25.6	13.3	20.9	41.2
	Dowicide A-hexamine treatments	1.5	3.9	26.2	6.9	18.3	37.7
55°F.	Commercial treatments	.7	4.9	16.7	10.1	15.0	33.3
	Dowicide A-hexamine treatments	1.5	4.8	19.9	11.8	22.4	46.2

[1] Data based on averages of subsamples (5-box lots).

TABLE 16. The effect of different temperatures and Dowicide A-hexamine on pitting in Duncan grapefruit stored at New York City, May 21, 1952.[1]

Storage temperature	Fruit treatment	Moderate and severe pitting after 4 weeks storage plus			Moderate and severe pitting after 8 weeks storage plus		
		0 days at 70°F.	3 days at 70°F.	7 days at 70°F.	0 days at 70°F.	3 days at 70°F.	7 days at 70°F.
		Percent	Percent	Percent	Percent	Percent	Percent
32°F.	Commercial treatments	1.7	2.4	3.1	3.2	24.7	19.0
	Dowicide A-hexamine treatments	2.7	4.7	5.1	3.9	19.4	16.8
38°F.	Commercial treatments	4.2	13.6	9.4	25.7	35.5	20.2
	Dowicide A-hexamine treatments	4.3	11.8	14.4	30.4	34.2	16.1
45°F.	Commercial treatments	4.2	11.1	11.0	41.7	33.9	18.8
	Dowicide A-hexamine treatments	6.9	18.7	17.3	35.2	36.5	21.2
50°F.	Commercial treatments	15.8	21.6	12.0	15.9	13.3	10.3
	Dowicide A-hexamine treatments	9.3	10.5	11.7	15.0	9.9	8.7
55°F.	Commercial treatments	4.0	4.2	5.9	3.6	2.0	1.6
	Dowicide A-hexamine treatments	8.4	10.2	9.9	4.8	3.0	5.1

[1] Data based on averages of subsamples (5-box lots).

TABLE 17. The effect of different storage temperatures and Dowicide A-hexamine on aging in Duncan grapefruit stored at New York City, May 21, 1952.[1]

Storage temperature	Fruit treatment	Severe aging after 4 weeks storage plus			Severe aging after 8 weeks storage plus		
		0 days at 70°F.	3 days at 70°F.	7 days at 70°F.	0 days at 70°F.	3 days at 70°F.	7 days at 70°F.
		Percent	Percent	Percent	Percent	Percent	Percent
32°F.	Commercial treatments	0	0	0	0	0	0
	Dowicide A-hexamine treatments	0	0	0	1.0	.6	.6
38°F.	Commercial treatments	0	1.7	1.0	4.6	8.8	3.3
	Dowicide A-hexamine treatments	.3	1.0	2.6	2.3	8.1	4.2
45°F.	Commercial treatments	.6	4.5	2.9	4.9	6.9	3.0
	Dowicide A-hexamine treatments	1.6	3.3	4.2	5.2	6.1	3.7
50°F.	Commercial treatments	.6	2.2	4.7	7.3	10.0	4.7
	Dowicide A-hexamine treatments	2.1	5.1	4.2	7.2	5.1	2.4
55°F.	Commercial treatments	0	.7	1.3	1.0	1.3	1.0
	Dowicide A-hexamine treatments	0	.3	.3	.3	1.2	.3

[1] Data based on averages of subsamples (5-box lots).

TABLE 18. The effect of Dowicide A-hexamine treatment on decay in stored grapefruit, 1952.[1]

Fruit treatment	Decay at first inspection after storage			Decay at second inspection after 3 days at 70°F.			Decay at third inspection after 7 days at 70°F.		
	Stem-end rot	Penicillium rot	Total of decay	Stem-end rot	Penicillium rot	Total of decay	Stem-end rot	Penicillium rot	Total of decay
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Commercial treatments	4.2	3.3	8.3	5.8	5.2	12.4	10.0	28.6	40.4
Dowicide A-hexamine treatments	2.3	1.0	3.8	3.4	2.0	6.3	6.5	17.7	25.5

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[1] Data based on averages obtained at Orlando, Florida, and New York, New York, for all prestorage treatments, naked packs, liner packs, storage temperatures, and storage periods.

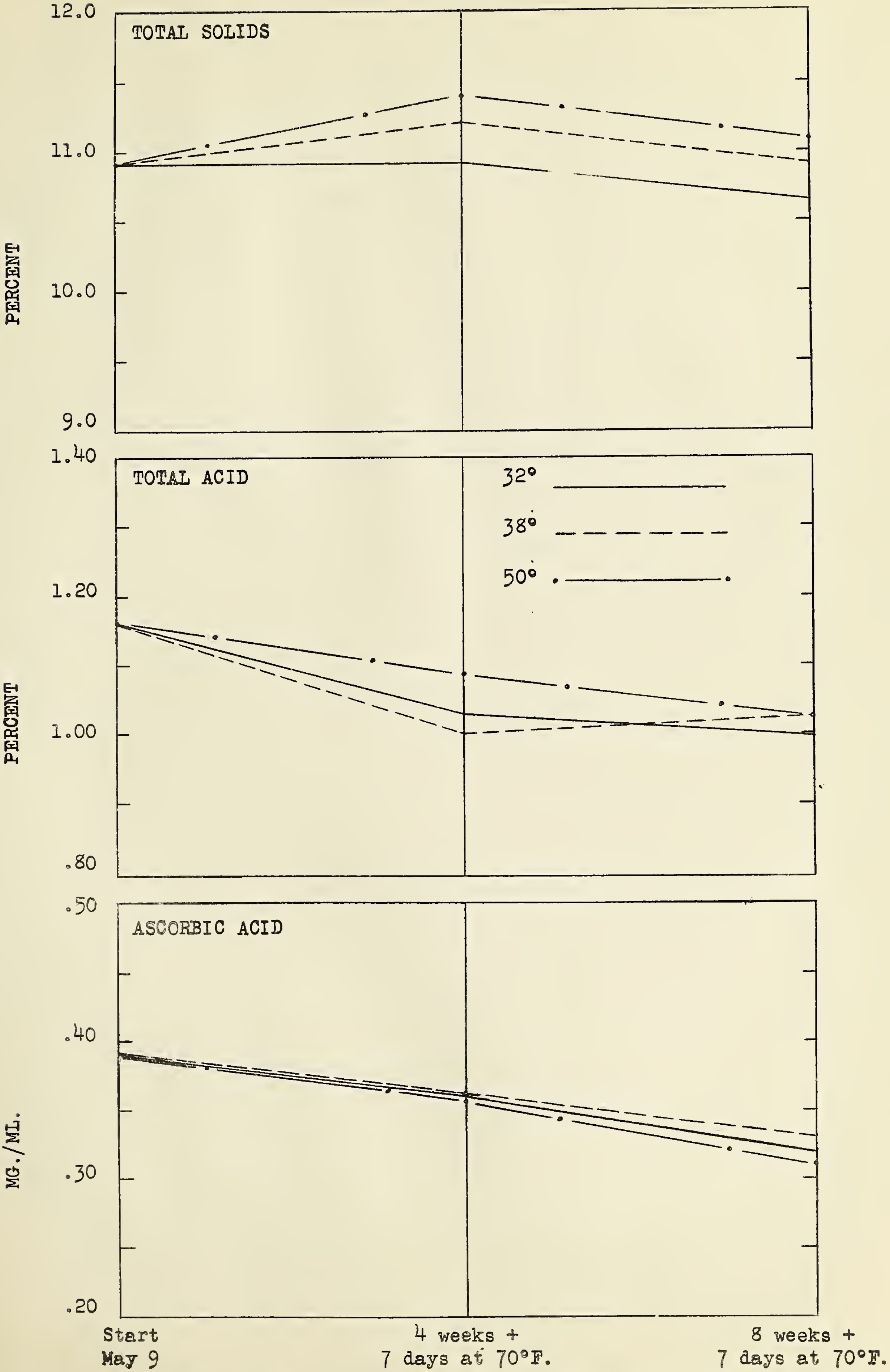

Figure 1. Changes in the composition of Duncan grapefruit stored at 32°, 38°, and 50°F., at Orlando, Florida, May 9, 1952.

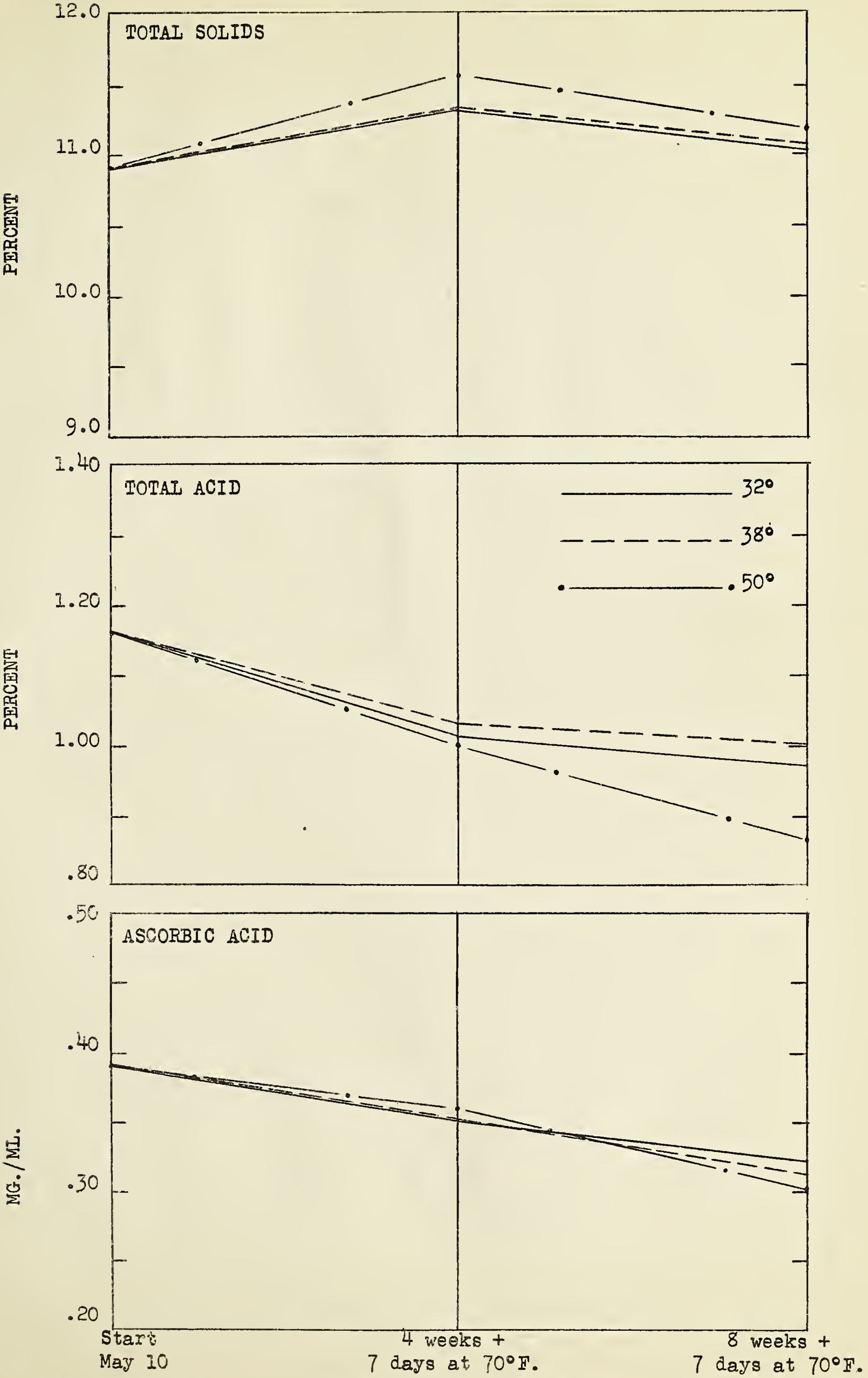

Figure 2. Changes in the composition of Duncan grapefruit cured 60 hours at 84°F. and stored at 32°, 38°, and 50°F., at Orlando, Florida, May 10, 1952.

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